49. (Cancelled) ~~The apparatus of claim 48, wherein, said forming component forms a tire seat bead having approximately a 5° angle.~~

50. (Original) The apparatus of claim 45, wherein, said forming component forms a flange into said rim portion of said unitary wheel.

51. (Original) The apparatus of claim 45, wherein, said forming component forms a unitary wheel having a flat or semi-drop center rim.

REMARKS

Status of the Claims

In the present Office Action, the Examiner asserted that no copy of the priority application was of record.

In the present Office Action, Figures 1-8 were objected to as not including the legend "Prior Art." Figures 1-15 were objected to as lacking reference characters. Reference character 1 was objected to as showing a flange, not a gutter. The Examiner further objected to the drawings, arguing that the drawings should when possible show the improved portion itself, when the invention comprises an invention over the prior art, and in particular, that the drawings do not show how a tire could be mounted on the rim of the present invention, asserting that the figures showed only a single bead seat and rim flange.

In the present Office Action, the Abstract of the invention was objected to.

In the present Office Action, the specification of the application was objected to as having the claims to priority in Paragraph 0009, not Paragraph 0001.

In the present Office Action, claims 3-5, 7, 29, 31, 36, and 40 were objected to as having several informalities.

In the present Office Action, claims 2, 16, 29-44, and 47 were rejected under 35 U.S.C. § 112 as being indefinite or unclear.

In the present Office Action, claims 1-4, 6-9, 11-19, 21-23, 25-28, 30-39, 45-48, and 50-51 were rejected under 35 U.S.C. § 102(b) as being anticipated by Jurus '810.

In the present Office Action, claims 1-51 were rejected under 35 U.S.C. § 102(e) as being anticipated by Srivathsan.

In the present Office Action, claims 5, 20, 29, 40-44, and 49 were rejected under 35 U.S.C. § 103(a) as being obvious over Jurus in view of Ashley et. al.

In the present Office Action, claims 10 and 24 were rejected under 35 U.S.C. § 103(a) as being obvious over Jurus in view of Beyer.

In the present Office Action, claims 1-51 were provisionally rejected on the ground of obviousness-type double patenting as being unpatentable over claims 1-51 of copending application 10/585,468.

In the present Office Action Response, Independent claims 41-44 are herein cancelled, and dependant claims 4, 5, 12, 13, 19, 20, 26-28, 38, 39, 48, and 49 are also cancelled.

Argument

1.0 The Present Application

Claims 1-51 are presently pending in the present application, titled Wheels of Single Component Construction and Method of Making, which is directed towards a method of manufacturing a unitary steel wheel having a 5° taper bead seat, equipment required therefore, and the resultant improved wheel. The application as pending comprises nine (9) independent claims, and 42 claims depending from those independent claims. Four (4) independent claims and thirteen (13) dependant claims are cancelled herein.

At the present, almost all commercially produced wheels are manufactured from several components, which are later joined to form a complete wheel assembly, which includes a center disk portion for mounting to the hub of a vehicle, and an outer rim portion, onto which a tire may be mounted. Wheels which form the center disk and the rim separately have issues regarding concentration of stresses resultant from the joining method, while wheels which use a multi-part rim section have not only stress concentration problems, but also sealing problems between the halves of the rings.

Prior art unitary wheels are limited, in that the shapes which could be formed were not practical with existing vehicle requirements, were formed out of materials such as aluminum, which do not share the strength and cost advantages of steel, or relied on processes which introduced adverse characteristics to partially formed wheels, such that later processing steps were impeded. Accordingly, the few attempts at the fabrication of unitary steel wheels have not been commercially successful.

The present invention utilizes a round steel blank which is spin formed to form a cylindrical section, which comprises the center disk and complete rim. The steel blank is provided with a center hole, the center of which forms the axis of rotation of the blank for the manufacturing operations. The blank is first spin formed to form a cylindrical preform, which is then further processed in a spin forming machine to form inner and outer bead seats and flanges on the cylindrical outer portion of the perform. One bead seat of the present invention utilizes a 5° taper. Finally, additional features as required, such as mounting bolt holes and vent holes to allow air circulation, may be formed on the unitary wheel.

Jurus, U.S. Pat. No. 4,554,810, is directed towards a segment of a complete wheel. The segment includes part of the outer rim, as well as the center disk. Jurus does require, however, that the second segment to complete the outer rim, be formed separately, and thus does not disclose a unitary wheel, or a method for forming one. In particular, the structure of Jurus does not include both bead seats on a unitary piece.

Evans U.S. Pat. No. 4,185,370 likewise does not disclose a unitary wheel, but rather only a method for forming the outer rim portion, leaving the center disk as a separate assembly.

Ashley Jr., et. al., U.S. Pat. No. 4,962,587 also does not disclose a unitary wheel, but rather a rim portion which would then have to be joined to a center disk.

Beyer U.S. Pat. No. 4,528,734 is thus the most relevant reference, as it does describe a unitary wheel, although the fabrication method is limited to the use of soft alloys, as a result of the reliance on forging to form the perform. The use of forging operations work hardens the material, as well as creates a second, significant limitation to the process of forming the wheel: as the preform is formed by forging, the center axis of the pre-form is not of necessity the same as the axis of the spin forming operation. Thus, not only can the resultant wheel have concentricity issues, spinning operations performed as a later part of the process may see large tool load variations resultant from the lack on concentricity. Thus, the formation of the pre-form through a forging process creates significant limitations, as opposed to the wheel of the present invention.

3.0 Copy of Priority Application

In the present Office Action, the Examiner noted that no copy of the priority application was of record.

The present Application is a U.S. National Application filed under 35 U.S.C. § 371, and accordingly Applicant believes that certified copies of the underlying Indian Applications are not required. Notwithstanding, Applicant submits herewith copies of the certified priority documents as Exhibit A.

4.0 Correction of Drawings

In the present Office Action, Figures 1-8 were objected to as not including the legend "Prior Art", and as lacking reference characters. Figures 1-15 were objected to as lacking reference characters.

Figures 1-8 all represent the prior art rim. Accordingly, the legend "Prior Art" has been added to Figures 1-8.

Applicant has further amended the specification and Figures to add additional reference characters. With respect to the failure of other Figures to illustrate a tire mounted on the rim of the present invention, or the rim of the present invention mounted on a vehicle, these claims have been cancelled, and accordingly the rejections are believed no longer relevant.

5.0 Correction of the Abstract

In the present Office Action, the Abstract of the invention was objected to. Applicant has revised the Abstract, and a substitute Abstract is submitted herewith.

6.0 Correction of the Priority Claim

In the present Office Action, the specification of the application was objected to as having the claims to priority in Paragraph 0009, not Paragraph 0001.

Paragraph 0009 has been moved to precede Paragraph 0001, and amended to properly reflect the present applications priority claim from PCT Application PCT/IN2005/000006, titled "Wheels of Unitary Construction and Method of Making Same," and accordingly the objection is believed overcome.

7.0 Correction of Informalities

In the present Office Action, claims 3-5, 7, 29, 31, 36, and 40 were objected to as having several informalities.

Claims 4 and 5 are herein cancelled, and the objections are thus believed moot. With respect to claims 3 and 7, the errant comma has been removed.

With respect to claim 29, the errant periods have been removed, as well as the requested comma added. The spelling of preform has been corrected (with apologies for the tendency of auto spelling correction to randomly correct preform to perform.) The requested replacements of the terms "of" and "of a" have been entered.

With respect to claim 31, spelling of preform has been corrected.

With respect to claim 36, a missing period has been added.

With respect to Claim 40, the preamble of the claim has been corrected to read "An apparatus," and a comma has been inserted after "flange", and after "blank".

8.0 Rejections under 35 U.S.C. § 112

In the present Office Action, claims 2, 16, 29-44, and 47 were rejected under 35 U.S.C. § 112 as being indefinite or unclear.

Claims 38, 39, and 41-44 have been herein cancelled, and accordingly the rejection is believed moot with respect to these claims.

Claims 2, 16, 29, 40-44, and 47 were rejected on the assertion that the term was being redefined to mean flange. Applicant disagrees with the assertion that Applicant has redefined "gutter" to have a meaning other than the meaning commonly understood in the art, i.e., a channel at the base of a bead seat to prevent a tire from displacing from the bead seat. The Examiner has asserted that the Figures identify the gutter as being the flange. While the gutter is generally partially formed by, and thus adjacent to, the flange, the flange is not specifically the gutter. Accordingly, the rejection is traversed.

Claim 29 was asserted to be indefinite, as including limitations addressing the forward direction and the backward direction. These are terms from a particular embodiment of the manufacturing process, are not believed to be necessary to the present invention, and accordingly

have been deleted. With respect to the phrase "formed in subsequent operations," this language has been deleted as it merely foreshadowed later steps to the method.

Claims 30 and 32 were rejected due to the use of the phrase "the same" to refer to the previously introduced blank. These claims have been amended to use the phrase "the blank", and accordingly the rejection is believed overcome.

Claims 35-36 and 40 were rejected due to the inclusion of the phrase "conventional press." The type of the press is irrelevant to the present invention, and the word "conventional" has been deleted.

As claims 41 and 42 have been herein cancelled, the rejections with respect to these claims are believed moot.

9.0 Rejections under 35 U.S.C. § 102(a)

9.1 Claims 1-4, 6-9, 11-19, 21-23, 25-28, 30-39, 45-48, and 50-51are not anticipated under 35 U.S.C. § 102(e) by Jurus '810

In the present Office Action, claims 1-4, 6-9, 11-19, 21-23, 25-28, 30-39, 45-48, and 50-51 were rejected under 35 U.S.C. § 102(b) as being anticipated by Jurus. Claims 1, 14, 29, 40, and 45 are the remaining independent claims in the present application, and the rejections are herein addressed with respect to the independent claims, such that the failure of Jurus to disclose key limitations in each of those claims prevents Jurus from anticipating the present invention as claimed.

With respect to claim 1, claim 1 as herein amended makes clear the distinctions between Jurus and the present invention, i.e., that Jurus does not disclose a unitary wheel(See, e.g., figure 2 of Jurus), in that Jurus forms a first portion which encompasses the center disk, and part of the outer rim, with a second part of the outer rim being formed as a separate component. Jurus thus at a minimum does not include a unitary wheel having two bead seats on the outer rim portion, and thus Jurus does not anticipate claim 1 of the present invention

With respect to claim 14, claim 14 as herein amended makes clear the distinctions between Jurus and the present invention, i.e., that Jurus does not disclose a unitary wheel, in that Jurus forms a first portion which encompasses the center disk, and part of the outer rim, with a

second part of the outer rim being formed as a separate component. Jurus thus at a minimum does not disclose a method involving forming two bead seats on the outer rim portion, and thus Jurus does not anticipate claim 14 of the present invention.

With respect to claim 29, claim 29 as herein amended makes clear the distinctions between Jurus and the present invention, i.e., that Jurus does not disclose a unitary wheel, in that Jurus forms a first portion which encompasses the center disk, and part of the outer rim, with a second part of the outer rim being formed as a separate component. Jurus thus at a minimum does not disclose a method involving forming two bead seats on the outer rim portion, and thus Jurus does not anticipate claim 29 of the present invention.

With respect to claim 40, claim 40 as herein amended makes clear the distinctions between Jurus and the present invention, i.e., that Jurus does not disclose a unitary wheel, in that Jurus forms a first portion which encompasses the center disk, and part of the outer rim, with a second part of the outer rim being formed as a separate component. The apparatus of Jurus shares these deficiencies. Jurus thus at a minimum does not disclose either a unitary wheel having two bead seats on the outer rim portion, or an apparatus for forming such a wheel, and thus Jurus does not anticipate claim 40 of the present invention

With respect to claim 45, claim 45 as herein amended makes clear the distinctions between Jurus and the present invention, i.e., that Jurus does not disclose a unitary wheel, in that Jurus forms a first portion which encompasses the center disk, and part of the outer rim, with a second part of the outer rim being formed as a separate component. The apparatus of Jurus shares these deficiencies. Jurus thus at a minimum does not disclose either a unitary wheel having two bead seats on the outer rim portion, or an apparatus for forming such a wheel, and thus Jurus does not anticipate claim 45 of the present invention

9.2 Claims 1-51 are not Anticipated under 35 U.S.C. § 102(e) by Srivathsan

In the present Office Action, claims 1-51 were rejected under 35 U.S.C. § 102(e) as being anticipated by Srivathsan. 35 U.S.C. § 120(e)(1) provides:

> (e)(1) An application for patent filed under section 111(a) or section 363 of this title for an invention disclosed in the manner provided by the first paragraph of section 112 of this title in a provisional

> application filed under section 111(b) of this title, by an inventor or inventors named in the provisional application, shall have the same effect, as to such invention, as though filed on the date of the provisional application filed under section 111(b) of this title, if the application for patent filed under section 111(a) or section 363 of this title is filed not later than 12 months after the date on which the provisional application was filed and if it contains or is amended to contain a specific reference to the provisional application.

The present application was filed pursuant to 35 U.S.C. § 371, with an appropriate priority claim under 35 U.S.C. § 363. Although the specification as filed failed to make note of the claim to priority from the PCT case has been corrected herein.

Further, the case asserted as being referenced as a 102(e) reference was filed on the same date as the present case, both with respect to the PCT filings underlying both cases, as well as the US applications underlying both applications.

Finally, the asserted reference is not the filing of another, as both applications have the same inventors, and are filed in the name of the same entity.

Accordingly, the asserted reference is not valid prior art, and the rejection is believed traversed.

10.0 <u>Rejections under 35 U.S.C. § 103(a)</u>

In the present Office Action, claims 5, 20, 29, 40-44, and 49 were rejected under 35 U.S.C. § 103(a) as being obvious over Jurus in view of Ashley et. al.

In the present Office Action, claims 10 and 24 were rejected under 35 U.S.C. § 103(a) as being obvious over Jurus in view of Beyer.

Claims 5, 20, 41-44, and 49 have been cancelled herein, and accordingly, only claims 10, 24, 29 and 40 remain subject to the asserted obviousness rejections.

10.1 Claim 29 is Not Obvious Over Jurus in view of Ashley

As noted above, neither Jurus nor Ashley discloses a unitary wheel, and thus the combination of Jurus and Ashley cannot render the present claim 29 obvious, as there is not only no teaching, but likewise no suggestion or motivation to combine the references to arrive at the

present invention. Jurus and Ashley both explicitly require a multi-part rim, with the attendant disadvantages associated therewith.

10.2 Claim 40 is Not Obvious Over Jurus in view of Ashley

As noted above, neither Jurus nor Ashley discloses a unitary wheel, and thus the combination of Jurus and Ashley cannot render the present claim 40 obvious, as there is not only no teaching, but likewise no suggestion or motivation to combine the references to arrive at the present invention. Jurus and Ashley both explicitly require a multi-part rim, with the attendant disadvantages associated therewith.

10.3 Claims 1 and 10 are not Obvious over the Cited References

As noted above, Jurus does not disclose a unitary wheel. Beyer does not disclose spin forming a center disk, but rather relies on forging, and is further limited to the use of soft alloys, thus teaching away from combining the spin formed steel center disk of the present invention. Furthermore, neither reference teaches the formation of a 5° bead seat in conjunction with a unitary wheel. Thus, the combination of Jurus and Beyer cannot render the present claim 1 obvious, as there is not only no teaching, but likewise no suggestion or motivation to combine the references to arrive at a unitary wheel having a 5° bead seat of the present invention. As claim 10 depends from claim 1, the limitations which are not taught or suggested by Jurus in view of Beyer are present in claim 10, and accordingly claim 10 cannot be obvious over the asserted combination either.

10.4 Claims 14 and 24 are not Obvious over the Cited References

As noted above, Jurus does not disclose a unitary wheel. Beyer does not disclose spin forming a center disk, but rather relies on forging, and is further limited to the use of soft alloys, thus teaching away from combining the spin formed steel center disk of the present invention. Furthermore, neither reference teaches the formation of a 5° bead seat in conjunction with a unitary wheel. Thus, the combination of Jurus and Beyer cannot render the present claim 14

obvious, as there is not only no teaching, but likewise no suggestion or motivation to combine the references to arrive at a unitary wheel having a 5^{o} bead seat of the present invention. As claim 24 depends from claim 14, the limitations which are not taught or suggested by Jurus in view of Beyer are present in claim 24, and accordingly claim 24 cannot be considered obvious over the asserted combination either.

11.0 Provisional Obviousness Type Double Patenting

In the present Office Action, the Examiner asserted a provisional rejection of claims 1-51 of the present invention.

Applicant does not agree that Applicant is claiming the same invention in both applications. While the inventions are clearly related, they are directed towards different products. Furthermore, as the scope of any claims to be allowed is unknown at this time, Applicant believes it premature to enter a terminal disclaimer in the absence of a comparison of allowable claims.

10.0 Conclusion

Based upon the above remarks, Applicant respectfully requests reconsideration and withdrawal of this restriction requirement and early allowance of the pending claims. Should the Examiner feel that a telephone conference with Applicant's attorney would expedite prosecution of this application, the Examiner is urged to contact the undersigned attorney.

Respectfully submitted,
REED SMITH LLP

Carl H. Pierce
Registration No. 45,730
2500 One Liberty Place
1650 Market Street
Philadelphia, PA 19103-7301
(215) 851-8100
Attorney for Applicant

EXHIBIT A

INTELLECTUAL PROPERTY
INDIA

सत्यमेव जयते

GOVERNMENT OF INDIA
PATENT OFFICE
Ministry of Commerce and Industry
Department of Industrial Policy and Promotion

It is hereby certified that annexed here to is a true copy of **Indian Patent Specification** of the Patent application as granted and detailed below:-

Date Of Patent : **07/01/2004**

Patent No. : 201310 **(12/CHE/2004)**

Patentee : **M/s. Wheels India Limited, Padi, Chennai – 600 050, an Indian Company.**

In witness there of
I have here unto set my hand

Dated this the 8th day of September 2010
17th day of Bhadrapada, 1932(Saka)

By Authority of
THE CONTROLLER GENERAL OF PATENTS,
DESIGNS AND TRADE MARKS.

(V. RENGASAMY)
DEPUTY CONTROLLER OF PATENTS & DESIGNS

PATENT OFFICE
INTELLECTUAL PROPERTY RIGHTS BUILDING
G.S.T. ROAD, GUINDY
CHENNAI – 600 032.

012/CHE/04

ORIGINAL

FORM 2

THE PATENTS ACT, 1970.

(39 of 1970)

COMPLETE SPECIFICATION

(See Section 10)

A METHOD OF MANUFACTURING INTEGRAL WHEEL RIM AND DISC ASSEMBLY OF A 5° TAPER BEAD-SEAT OF FLAT OR SEMI-DROP CENTER RIM AND INTEGRAL WHEEL CONSTRUCTION

WHEELS INDIA LIMITED
PADI, CHENNAI 600 050.

Nationality : Indian

The following specification particularly describes the nature of invention and the manner in which it is to be performed.

Best Available Copy

FIELD OF INVENTION

This invention in general relates to road wheels of vehicles. In particular this invention relates to construction of vehicle steel wheel of 5^0 taper bead-seat of flat or semi-drop center rim used but not limited for commercial use. This invention further relates to a method of manufacturing the said type of wheel.

The 5^0 taper bead-seat wheel tire bead seat area would have a 5^0 taper and profile (where tire contact is involved) as defined in the international tire and rim standards / manuals / hand books such as ETRTO, T&RA, JATMA. This is applicable for all 5^0 bead seat rims i.e. it includes semi drop center, flat base etc. Mainly this is for tube type application. It can be used as tubeless type only when a suitable sealing exists (as recommended by tire manufacturer). It has to be used along with the suitable removable flange / flanges (as recommended by wheel manufacturer) at the end/ends of the rim.

This invention relates to a construction, apparatus and a method of producing integral wheel rim and disc assembly of a 5^0 taper bead-seat of flat or semi-drop center rim, providing a generally circular steel blank from a sheet stock of pre-determined uniform thickness, the blank is preferably with a center hole pierced to a predetermined size. The blank is preformed in spinning machine to a predetermined cylindrical profile & shape, such perform is further spun and flow formed in a spinning machine, the preform being positioned between an outer roll & inner mandrel and held against the clamping plate, such inner mandrel comprise of a outboard surface which conforms to the predetermined inner diameter of the rim comprising of gutter portion, the well, the bead-seat and fixed flange and such outer roll comprise of outboard surface which confirms to the final shape and profile of the gutter wall. The preform peripheral cylindrical portion is then spun against the outboard surface of the inner mandrel & outboard surface of the outer roll to displace the material in backward & forward direction to the final profile and shape of the gutter wall and predetermined profile & form of well, bead-seat, fixed flange respectively. The spun rim comprising of gutter, well and bead seat is further spun and flow formed in a spinning machine, being positioned between an outer mandrel and an inner clamping plate, such outer mandrel comprise of a inboard surface which conforms to the final shape of the fixed flange and 5^0 angle to the bead-seat, is spun and flow formed against the inner surface of the outer mandrel by a shaping roller of predetermined shape to form the final shape of the fixed flange and 5^0 bead-seat

PRIOR ART

In its most conventional form, a fabricated sheet steel wheel of a 5^0 taper bead-seat of flat-base or semi-drop center rims for a vehicle, the rim inner periphery have welded or jointed central disc also made of sheet steel. The tire mounts on the outer periphery of the rim supported by the central disc, which provides a means of attachment to spindle hubs, brake drum or other like associated parts of the vehicle. It is essential that the rim and disc, in their assembled relationship, insure perfect roundness of the rim and accurate axial alignment of the rim with respect to the disc. Deviations in the respective directions being termed as "radial" and "axial" run-outs, the Vehicle manufacturers establish extremely rigid specifications in the tolerances for these dimensions.

When such wheels are manufactured in the conventional method, the rim and discs are normally made as separate components. These two components are then

assembled together in a press or in a fixture, the disc fixed at its outer peripheral flange to the inner periphery of the rim by welding or some other like method to form the complete wheel assembly. In the conventional method of making the rims by using a butt-welded hoop made out of a strip of hot rolled sections or plate, achieving such a close tolerance on the roundness has found to be extremely difficult due to the localized "kink" in the region of butt welded joint and the non-uniform spring back during the rim diameter calibration operation. Likewise accurate dimensional control in making the disc are also found difficult due to cold press forming inconsistency, brought about by dimensional and properties variation of the input material. Further substantial distortion due to welding the two parts requires further corrective additional costly operation to ensure that the axial alignment is held within limits. It is appreciated by the people who are skilled in the manufacturing wheels that such distortion once occurred cannot be corrected completely and a welded assembly does not lend itself well to the rigorous balancing and centering of the wheel Such shift in the axial alignment and also the localized kink in the rim in the region of the butt welded joint is known to produce first harmonics during vehicle running causing vibration and high noise. The axial shift between the disc and the rim also produces imbalance of the wheel causing vehicle disturbance or thumping / shake.

Further when such wheels have been run with test overloads to induce failure, fatigue cracks have usually occurred in the center of the disc where it is attached to its supporting axle and in the welds, which have attached the rim to the disc.

Another problem of the wheel of conventional design is due to the constraint of using break drum of larger size. This is due to the disc peripheral portion being assembled under the rim, thus restricting space for accommodating a break drum of larger size. Today's vehicle carries more loads at high speed. From the point of view safety it is necessary to provide for a greater area for a larger envelope break components for improved breaking performance.

The use of integral wheel rim and disc assembly of a 5^0 taper bead-seat of flat or semi-drop center rims of low carbon and high strength steel, would lead to a noticeable reduction in weight, would facilitate balancing and centering.

It is well recognized that wheels are not only critical to the safety of an automotive vehicle but also being an un-sprung mass has a pronounced effect on vehicle stability and driving comfort. It is thus obvious that only an integral wheel rim and disc assembly of a 5^0 taper bead-seat of flat or semi-drop center rims construction and a method of manufacturing the same would satisfy the requirement as enumerated as above.

However, up to the present time none of the prior processes has enabled to be produced a integral wheel rim and disc assembly of a 5^0 taper bead-seat of flat or semi-drop center rims construction under satisfactory technical and/or economic conditions, either on account of the fact that they do not lend themselves to mass production at an attractive cost price, or on account of the fact that the wheels obtained do not satisfy the requirements of the users, strength, minimal unbalance and first harmonic content, and accuracy of the significant dimensional characteristics.

The present invention relates to a apparatus and method for producing integral steel wheel rim and disc assembly of a 5^0 taper bead-seat of flat base or semi-drop center rims for vehicles, which lends itself particularly well to mass production and provides wheels which meet the requirements of users such as have just been enumerated above. A vehicle integral wheel rim and disc assembly of a 5^0 taper bead-seat of flat

or semi-drop center rims requires less material to construct and is substantially simpler to fabricate as there are fewer parts to construct and there are no assembly & welding steps involved, thus resulting in cost savings.

OBJECTS OF THE INVENTION

Accordingly, it is an object of the present invention to provide an integral steel wheel rim and disc assembly for vehicle wheel of 5^0 taper bead-seat of flat-base or semi-drop center construction, and an method and apparatus for making the same, which overcome the aforementioned problems in an economical and reliable manner.

It is another object of invention to provide an improved method of manufacturing of a vehicle wheel in a way that reduces manufacturing cost while providing high strength wheel

It is further object of invention to provide for a construction that reduces the wheel weight substantially, yet providing the high strength wheel.

It is yet another object of invention to provide for a greater air space for a larger envelope brake components for improved braking performance.

It is still another object of invention to provide for a wheel having very low radial and lateral run outs.

Yet another object of invention is to provide for a wheel having very low first harmonic content.

It is another object of invention to provide for a wheel having very low unbalance.

It is another object of invention to provide a method whereby a family of vehicle wheels having any plurality of axial width; diameter and offset may be produced from the blanks.

It is another object of invention to provide which would improve uniformity characteristics and increased fatigue life.

A further object is to provide improved apparatus of the aforementioned character, which is economical to set-up, and adjust.

Another object of the invention is to provide an improved manufacturing system, which requires only relatively small number of process steps, which can be carried out efficiently, and economically by automated equipment.

SUMMARY OF THE INVENTION

One aspect of the present invention is a unique cold forward & reverse spinning & flow forming method for manufacturing integral steel wheel rim and disc assembly for vehicle steel wheels of 5^0 taper bead-seat of flat-base or semi-drop center construction. Generally providing circular steel blank from a sheet stock of pre-determined uniform thickness, the blank is preferably with a center hole pierced to a predetermined size. The blank is preformed in a spinning machine to a predetermined profile & shape, such perform is further spun and flow formed in a spinning machine while the preform being positioned between an outer roll & inner mandrel and held against the clamping plate, such inner mandrel comprise of a outboard surface which conforms to the predetermined inner diameter of the rim comprising of gutter portion,

well, the bead-seat and fixed flange and such outer roll comprise of outboard surface which confirms to the final shape and profile of the gutter wall. The preform peripheral portion is then forward & revere spun against the outboard surface of the inner mandrel & outboard surface of the outer ring to a predetermined profile & form well, bead-seat, fixed flange and the final profile and shape of the gutter wall respectively. The spun rim comprising of gutter, well and bead seat is further spun and flow formed in a spinning machine, being positioned between an outer mandrel and an inner clamping plate, such outer mandrel comprise of a inboard surface which conforms to the final shape of the fixed flange and 5^0 bead-seat, is spun and flow formed against the inner surface of the outer mandrel by a shaping roller of predetermined shape to form the final shape of the fixed flange and 5^0 bead-seat.

Before backward & forward spinning of the preform, the preform is subjected to such operations where the central hole, mounting holes and the vent holes are pierced to a required size.

After final rim profiling & shaping operation, the center hole and the mounting holes are machined accurately.

The principal objects of the present invention are to provide a unique, low cost method of press forming, spinning & flow forming a integral wheel rim and disc assembly of a 5^0 taper bead-seat of flat or semi-drop center rims and the like. Steel blank is formed from sheet stock, and is spin and flow formed in a spinning operation to reduce manufacturing costs. The spinning & flow forming technique employs tools with a simple forming surfaces, which minimizes their associated manufacturing cost, as well as repair expenses. The spin forming machine can be easily programmed to form different shapes, such that the present method is especially suited for making specialty and/or low volume wheel designs as well as particularly well adapted for manufacturing one-piece type vehicle wheels for bulk manufacturing.

These and other advantages of the invention will be further understood and appreciated by those skilled in the art by reference to the following written specification, claims and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawing is intended to provide further understanding of invention and is incorporated in and constitutes a part of invention. The drawings illustrate an embodiment of invention and together with the description illustrate principle of invention.

The drawings should not be taken as implying any necessary limitation on the essential scope of invention.

The drawings are given by way of non-limitative example to explain the nature of the invention.

For a more complete understanding of the instant invention reference is now made to the following description taken in conjunction with accompanying drawings.

The various feature of novelty which characterize the invention are pointed out specifically in the claims which a part of description. For a better understanding of the invention, its operating advantage, specific objects obtained by its use, reference

should be made to the drawings and descriptive matter is which there are illustrated and described preferred embodiments of invention.

Referring now to drawings, where like numerals designate identical or corresponding parts throughout the referred views.

Fig 1 – shows sectional view of a disc blank of the welded 5^0 taper bead-seat of flat-base or semi-drop center construction wheel of the prior art.

Fig 2 - shows sectional view of a formed disc of the welded 5^0 taper bead-seat of flat base or semi-drop center wheels of the prior art.

Fig 3 – shows sectional view of a disc with mounting, central and vent holes of the welded 5^0 taper bead-seat of flat base or semi-drop center wheels of the prior art.

Fig 4 – shows a schematic representation the welded hoop from flat plate for the manufacture of rims for welded 5^0 taper bead-seat of flat base or semi-drop center wheels of the prior art.

Fig 5 - shows a schematic representation the welded hoop from mill section for the manufacture of rims for welded 5^0 taper bead-seat of flat base or semi-drop center wheels of the prior art.

Fig 6 - shows a schematic representation the rolling operation involved in producing rims for welded 5^0 taper bead-seat of flat base or semi-drop center wheels of the prior art

Fig 7 - shows a schematic representation the calibration process steps involved in producing rims for welded 5^0 taper bead-seat of flat base or semi-drop center wheels of the prior art

Fig 8 - shows a schematic representation the assembled disc & rim & welded 5^0 taper bead-seat of flat base or semi-drop center wheels of the prior art.

Fig 9 – Shows a sectional view of disc steel blank with center hole of the one-piece steel wheel for producing integral wheel rim and disc assembly of a 5^0 taper bead-seat of flat or semi-drop center rim in accordance with the present invention.

Fig 10 – shows a schematic representation of the first stage of spinning process of the producing integral wheel rim and disc assembly of a 5^0 taper bead-seat of flat or semi-drop center rim in accordance with the present invention.

Fig 11 – shows a schematic representation of the spun wheel from the previous step, wherein the mounting and center hole is pierced in accordance with the present invention.

Fig 12 - shows a schematic representation of the spun wheel from the previous step wherein the vent holes are pierced in accordance with the present invention.

Fig 13 - shows a schematic representation of the second stage of shows a schematic representation of the second stage of forward and backward displacement of material during spinning process of producing integral wheel rim and disc assembly of a 5^0 taper bead-seat of flat or semi-drop center rim in accordance with the present invention

Fig 14 – shows a schematic representation of the final stage of spinning process of producing integral wheel rim and disc assembly of a 5^0 taper bead-seat of flat or semi-drop center rim where the bead-seat and fixed flange are formed to the final profile and shape in accordance with the present invention

Fig 15 – shows schematic representation of the spun wheel from the previous step, wherein the fixed flange edges are machined.

Fig 16 - shows a perceptive view of the one-piece steel wheel of integral wheel rim and disc assembly of a 5^0 taper bead-seat of flat or semi-drop center rim in accordance with the present invention.

DETAILED DESCRIPTION OF THE PRIOR ART AND THE PREFERRED EMBODIMENTS

The steps involved in the manufacture of steel discs are blanking of the circular blank of pre-determined thickness, press-forming and piercing the center hole, mounting and vent holes as shown in Fig 1, Fig 2 and Fig 3.

The conventional method of producing the steel wheel is shown in Fig 1 to Fig 8. In the conventional method the disc and the rim are manufactured as separate components then welded or jointed by other means after assembly.

The rim is manufactured either by using a flat plate of uniform thickness or using the profiled hot rolled plate as shown in Fig 4 and Fig 5. In either case the plate is coiled into a hoop, but welded, joint trimmed and dressed. In the case of flat plate, the profile of the rim is achieved using press or spinning operations either hot or cold. Finally the rims are roll formed & calibrated for the diameter and out-of roundness accuracy as shown in the Fig 6 and Fig 7.

The finished discs and the rims are assembled in a press or a fixture and the joints are welded or jointed by other means after assembly. The wheels subsequently under goes several machining steps to machine center spigot and bolt hole as shown in Fig 8.

PREFERRED EMBODIMENTS OF THE INVENTION

Our preferred embodiment of invention is shown in Fig 9 to Fig 15. The following description is of the best presently contemplated mode of carrying out the invention. This description is made for the purpose of illustrating the general principles of the invention and should not be taken in a limiting sense. The scope of the invention is best determined by reference to the appended claims

The first step of manufacturing a integral steel wheel rim and disc assembly for 5^0 taper bead-seat of flat base or semi-drop center steel wheels involves a spinning and flow forming operation as shown in Fig 10, where in the steel blank of pre-determined diameter and thickness, the blank is preferably with a center hole pierced to a predetermined size, is spun and flow formed in a CNC 4-axis spinning machine to an predetermined shape. The operation is now explained in greater detail. The blank is held between inner mandrel M1 and the clamping plate C1. The roller R1 mounted on CNC hydraulically actuated slide, impart rolling pressure on the outer peripheral of the blank to reduce the thickness and at the same time give predetermined cylindrical shape and profile to the blank as per the predefined machine program. The outboard

surface of the inner mandrel M1 corresponds to the predetermined inner diameter of rim portion.

The next involves piercing mounting, central and vent holes as shown in the Fig 11 & Fig 12.

The next step involve forward & backward spinning to extend the cylindrical portion of the perform from the first step to an cylindrical shape of predetermined inner diameter and width comprising of gutter region, well and the fixed flange as shown in Fig 13 and at the same time cylindrical portion comprising of gutter region is backward spun as shown to a predetermined inner diameter and width. The operation is now explained in greater detail. The preformed blank as shown in Fig 12, is spun and flow formed in a CNC 4-axis spinning machine. The preformed blank is positioned between inner mandrel M2 and outer roll R2 and clamped prior to spinning operation by the clamping plate C2. The roller R2 mounted on CNC hydraulically actuated slide impart rolling pressure on the outer peripheral of the preformed blank to reduce the thickness at the required region and at the same time extend the cylindrical portion to a predetermined shape and profile as per the predefined machine program. The outboard surface of the inner mandrel M2 corresponds to the predetermined inner diameter of the rim. The next sequence is the backward displacement of material during spinning operation. The perform cylindrical portion comprising of the gutter portion is spun against an outer roll S2, such outer roll outboard surface corresponding to the predetermined shape of the gutter profile. The roller R2 is used for both forward and backward displacement of material as shown in the drawing.

The next and the final step involve profiling the fixed flange portion as shown in Fig 14. The spun rim from previous step comprising of gutter, well and bead seat is further spun and flow formed in a spinning machine, being positioned between an outer mandrel and clamped with an inner clamping plate, such outer mandrel comprise of a inboard surface which conforms to the final shape of the fixed flange and 5^0 bead-seat, is spun and flow formed against the inner surface of the outer mandrel by a shaping roller of predetermined shape to form the final shape of the fixed flange and 5^0 bead-seat. The operation is explained in a greater detail. The preformed blank from previous step comprising of gutter, well and bead seat is positioned between outer mandrel S3 and clamped with an inner clamping plate C3. The roller R3 mounted on CNC hydraulically actuated slide impart rolling pressure on the inner peripheral of the preformed blank to reduce the thickness at the required region and at the same time extend the cylindrical portion to a predetermined shape and profile as per the predefined machine program to the final profile & shape of the 5^0 bead-seat & fixed flange.

SALIENT FEATURES OF THE INVENTION ARE AS FOLLOWS:

A design / construction of a integral steel wheel rim and disc assembly for 5^0 taper bead-seat of flat base or semi-drop center wheels of the type having an integral disc and rim portion with gutter, well, 5^0 taper bead-seat and the fixed flange.

A method of producing the wheel consists in, providing generally circular steel blank; spinning the blank to of pre-determined uniform thickness and size. The blank is preferably with a center hole pierced to a predetermined size. The blank is preformed in a spinning operation, such perform further forward & reverse spun in a spinning machine, being positioned between an mandrel, outer roll and the clamping plate, such inner mandrel having a outboard surface which conforms to the cylindrical predetermined shape of the rim gutter, well, fixed flange & such outer roll have an

outboard surface corresponding to the gutter profile. The spun perform inner peripheral portions is spin and flow formed against the surface of the inner mandrel to form the final shapes of the rim 5^0 bead seat and flange.

The method has the step of spin forming the peripheral portion of the blank by engaging the same with a forming roller so as to obtain controlled thickness reduction and shape in the peripheral portion of the blank.

The method has the step of backward spinning a section of the blank peripheral portion against the shaping surface of an outwardly positioned roll to form the final shape of the rim gutter.

The method has the step of spin forming a section of the blank peripheral portion by engaging the same with a forming roller to form the final shape of the well base shape and dimension and at least a portion of the bead seat.

The method has the step of spin forming the bead seat portion of the blank inboard section against the shaping surface of the outer mandrel to form the final shape of fixed flange.

A method has the step wherein first-named spin forming step includes a plurality of passes of the forming roller.

A method has the step wherein after finish spinning operation bolt holes on pierced in a conventional press.

A method has the step wherein after piercing the bolt holes, vent holes are pierced in a conventional press

The method also includes the step of providing a disc blank of substantially uniform thickness and constructed HSLA steel composition.

Throughout this detailed description, reference is made to the tools and dies that perform the various shaping operations. Because the toolings used in each of the shaping operations are conventional devices, which are well known in the metal stamping/forming arts, detail description of the same has not been provided.

It is to be understood that the invention may assume various alternative orientations and step sequences, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification are simply exemplary embodiments of the inventive concepts defined in the appended claims. Hence, specific dimensions and other physical characteristics relating to the embodiments disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise.

Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be regarded as falling within the scope of the invention as defined by the claims that follow.

WE CLAIM

1. A method of manufacturing a integral steel wheel rim and disc assembly for 5^0 taper bead-seat of flat base or semi-drop center wheels of the type having an integral disc and rim portion with gutter, well, 5^0 bead-seat and fixed flange wherein the said method comprises the following steps

    a) Providing a generally circular blank;

    b) The blank is preferably of pre-determined uniform thickness

    c) The blank is preferably with a center hole pierced to a predetermined size.

    d) Preforming the blank to predetermined shape & size, the preform blank is spun & flow formed in a CNC spinning machine, being positioned between a inner mandrel and clamping plate, such mandrel having a outboard surface of predetermined cylindrical shape confirming to predetermined cylindrical shape & profile of the rim gutter, well and fixed flange.

    e) The spun and flow formed preform to an predetermined cylindrical shape & size is further spun in a CNC spinning machine to reduce thickness consequently to increase the width in the forward direction to an predetermined size while maintaining the predetermined inner diameter wherein the well, bead seat and the fixed flange are formed in the subsequent operations and at the same time further spinning is preformed on the peripheral portion of the cylinder to displace the preform cylindrical peripheral portion in the backward direction, against the outboard surface of the inner mandrel & outboard surface of the outer ring to a predetermined profile & form of well, bead-seat, fixed flange and the final profile and shape of the gutter wall respectively.

    f) The spun preform comprising of finished gutter profile, and cylindrical portion comprising of predetermined shape of the well, bead seat & fixed flange is further spun and flow formed in a spinning machine, the perform being positioned between an outer mandrel and an inner clamping plate, such outer mandrel comprise of a inboard surface which conforms to the final shape of the fixed flange and 5^0 angle bead-seat, is spun and flow formed against the inner surface of the outer mandrel by a shaping roller of predetermined shape to form the final shape of the fixed flange and 5^0 bead seat.

2. The method as claimed in claim 1 wherein spin forming the peripheral & inner portion of the blank by engaging the same with a forming roller so as to obtain controlled thickness reduction and shape in the peripheral and inner portion of the blank.

3. The method as claimed in claim 1 wherein the material is displaced in the backward direction during spinning a portion of the perform peripheral cylindrical portion against the outboard surface of an outwardly positioned roll to form the final shape of the rim gutter.

4. The method as claimed in claim 1 wherein spin forming an section of the blank peripheral portion by engaging the same with a forming roller to form the final shape of the well base shape and dimension and at least a portion of the bead seat.

5. The method as claimed in claim 1 wherein spin forming the bead seat portion of the blank outboard section against the shaping surface of the outer mandrel to form the final shape of bead seat & fixed flange.

6. The method as claimed in claim 1, wherein: said first-named spin forming step consists a plurality of passes of the forming roller.

7. The method as claimed in claim 1 wherein after first step of spinning operation, boltholes are pierced in a conventional press.

8. The method as claimed in claim 1 wherein after piercing the bolt holes, vent holes are pierced in a conventional press

9. The method as claimed in claim 1 wherein said step (a) consists the step of providing a disc blank of substantially uniform thickness of low carbon steel or HSLA steel composition.

10. The method as claimed in claim 1 wherein a butt-welded hoop of predetermined diameter, width and thickness can also be used instead of a blank.

11. The method as claimed in 10 wherein the butt-welded hoop of predetermined diameter, width and thickness can also be used to manufacture the rim part alone.

12. Apparatus for manufacturing a integral steel wheel rim and disc assembly for 5^0 taper bead-seat of flat base or semi-drop center wheels of the type having an integral disc and rim portion with gutter, well-base, bead-seat and fixed flange wherein the said method comprises means for providing a generally circular blank means for forming the blank to of pre-determined uniform thickness the blank is preferably with a center hole pierced to a predetermined size, the blank is pre-formed in a conventional press, the pre-form blank further spun in a spinning machine, being positioned between an mandrel having a surface which conforms to the final shape of the rim gutter, well, fixed flange and the clamping plate, the blank peripheral & inner portions is spun and flow formed against the surface of the inner or outer mandrel to form the final shapes of the rim gutter, well and the inboard bead seat and flange.

13. Apparatus for manufacturing a integral steel wheel rim and disc assembly for 5^0 taper bead-seat of flat base or semi-drop center wheels for a vehicle having an integral disc and rim portion with gutter, well base, bead-seat and fixed flange manufactured by the process claimed in claim 1.

14. A integral steel wheel rim and disc assembly for 5^0 taper bead-seat of flat base or semi-drop center wheels for a vehicle having an integral disc and rim portion with gutter, well-base, bead-seat and fixed flange wherein when spin forming machine is programmed to form different shapes.

15. A method of manufacturing a integral steel wheel rim and disc assembly for 5^0 taper bead-seat of flat base or semi-drop center wheels for a vehicle having an integral disc and rim portion with gutter, well-base, bead-seat and fixed flange as

described in the description of complete specification and as illustrated by way of drawings accompanying the complete specification.

16. A integral steel wheel rim and disc assembly for 5^0 taper bead-seat of flat base or semi-drop center wheels for a vehicle having an integral disc and rim portion with gutter, well-base, bead-seat and fixed flange as described in the description of complete specification and as illustrated by way of drawings accompanying the complete specification.

Dated this the 7th day of January 2004.

For WHEELS INDIA LIMITED

S. Srivatsan
VICE PRESIDENT (FINANCE) & SECRETARY

Signature of Applicant

ABSTRACT

This invention relates to a construction, apparatus and a method of producing integral wheel rim and disc assembly of a 5^0 taper bead-seat of flat or semi-drop center rim, providing a generally circular steel blank from a sheet stock of pre-determined uniform thickness, the blank is preferably with a center hole pierced to a predetermined size. The blank is preformed in spinning machine to a predetermined profile & shape, such perform is further spun and flow formed in a spinning machine, the preform being positioned between an outer roll & inner mandrel and held against the clamping plate, such inner mandrel comprise of a outboard surface which conforms to the predetermined inner diameter of the rim comprising of gutter portion, the well, the bead-seat and fixed flange and such outer roll comprise of outboard surface which confirms to the final shape and profile of the gutter wall. The preform peripheral portion is then forward & revere spun against the outboard surface of the inner mandrel & outboard surface of the outer roll to a the final profile and shape of the gutter wall and predetermined profile & form of well, bead-seat, fixed flange respectively. The spun rim comprising of gutter, well and bead seat is further spun and flow formed in a spinning machine, being positioned between an outer mandrel and an inner clamping plate, such outer mandrel comprise of a inboard surface which conforms to the final shape of the fixed flange and 5^0 angle to the bead-seat, is spun and flow formed against the inner surface of the outer mandrel by a shaping roller of predetermined shape to form the final shape of the fixed flange and 5^0 bead-seat.

NAME OF THE APPLICANT: WHEELS INDIA LIMITED

Application No. 0012/CHE/04

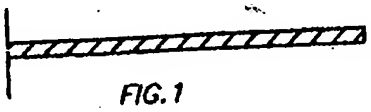


FIG.1

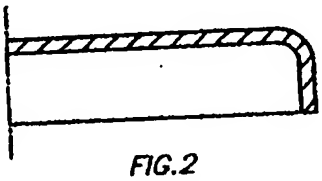


FIG.2

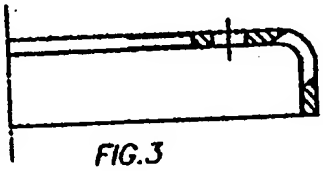


FIG.3

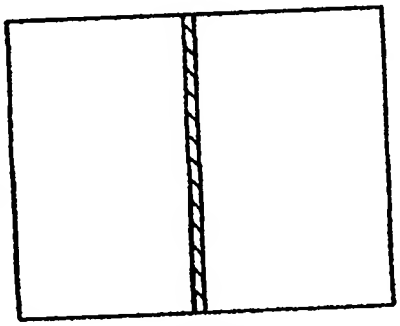


FIG.4

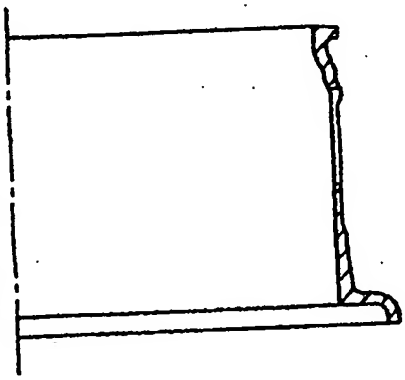


FIG.5

PRIOR ART

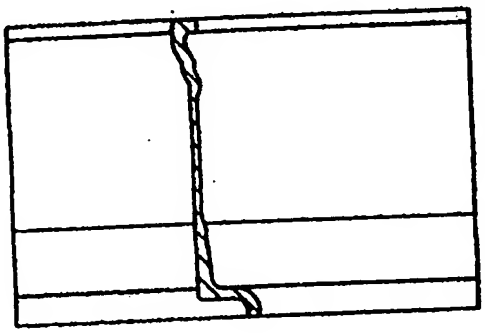


FIG.6

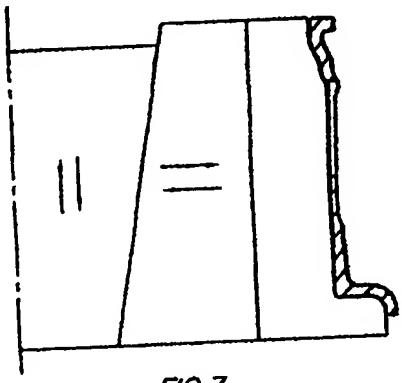


FIG.7

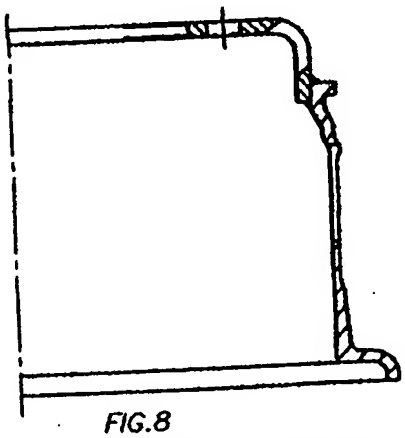


FIG.8

5° TAPER BEAD SEAT FLAT OR SEMI DROP CENTRE WHEELS.

SIGNATURE OF APPLICANT: (S. SRIVADHSAN)

NAME OF THE APPLICANT: WHEELS INDIA LIMITED

Application No. 0012/CHE/04

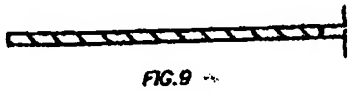


FIG.9

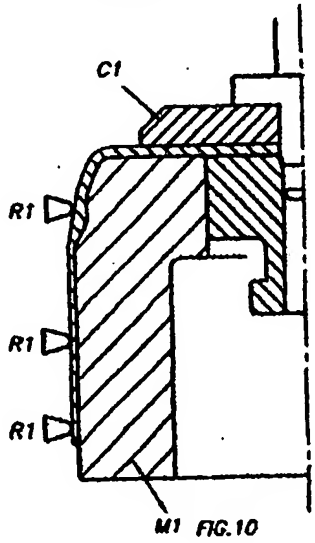


FIG.10

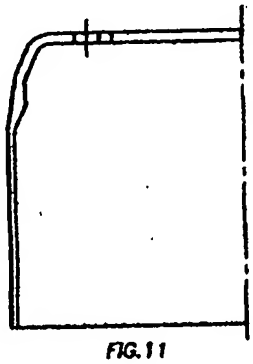


FIG.11

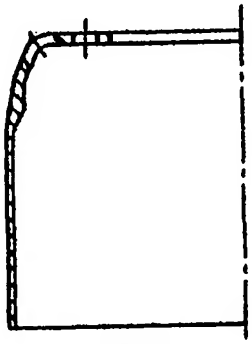


FIG.12

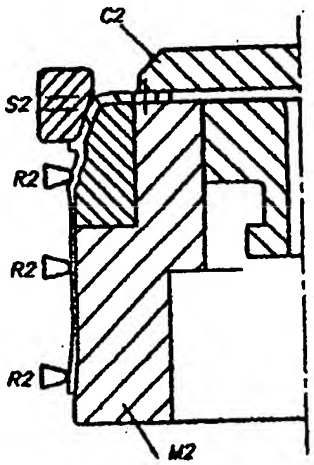


FIG.13

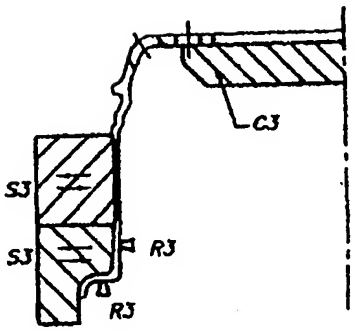


FIG.14

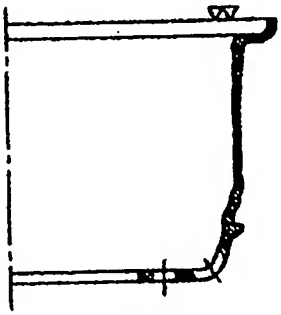
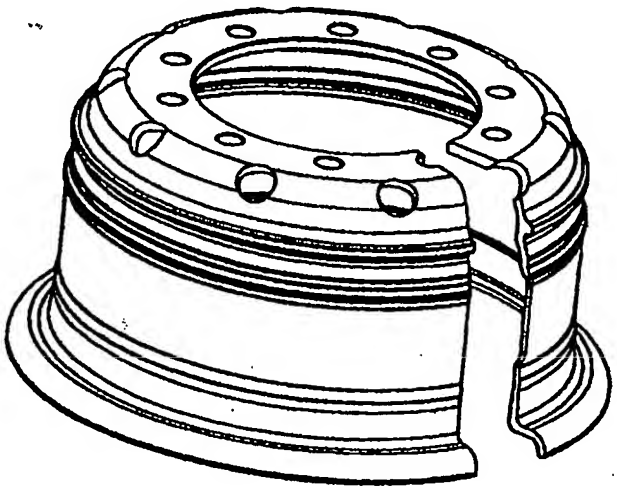


FIG.15

SIGNATURE OF APPLICANT: (S. SRIVATHSAN)

NAME OF THE APPLICANT: WHEELS INDIA LIMITED

Application No. 0012/CHE/04



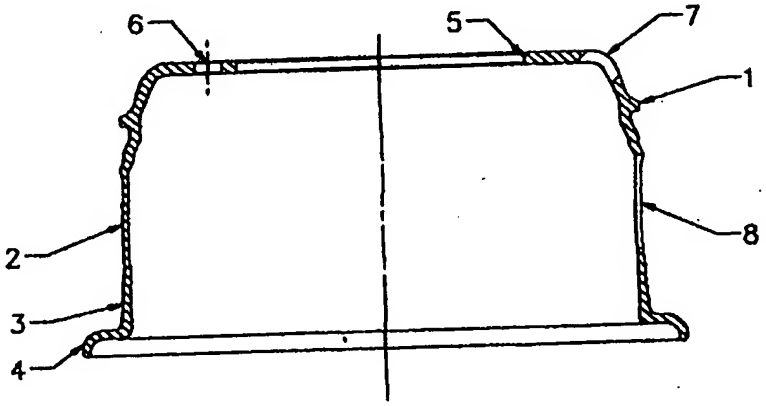
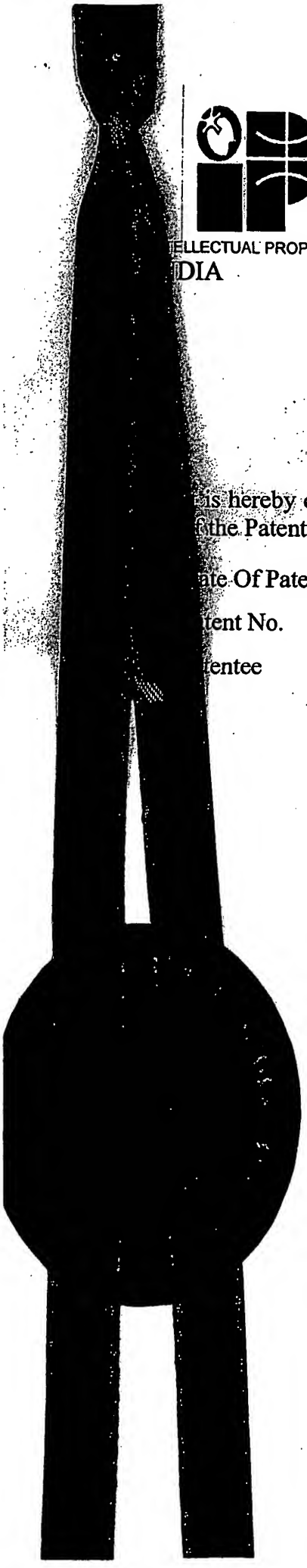


FIG.16

SIGNATURE OF APPLICANT: (S. SRIVATHSAN)
NAME OF THE APPLICANT: WHEELS INDIA LIMITED



ELLECTUAL PROPERTY
DIA

सत्यमेव जयते

GOVERNMENT OF INDIA
PATENT OFFICE
Ministry of Commerce and Industry
Department of Industrial Policy and Promotion

is hereby certified that annexed here to is a true copy of **Indian Patent Specification** the Patent application as granted and detailed below:-

ate Of Patent : **07/01/2004**

tent No. : **201314 (13/CHE/2004)**

entee : **M/s. Wheels India Limited, Padi, Chennai – 600 050, an Indian Company.**

In witness there of
I have here unto set my hand

Dated this the 8th day of September 2010
17th day of Bhadrapada, 1932(Saka)

By Authority of
THE CONTROLLER GENERAL OF PATENTS,
DESIGNS AND TRADE MARKS.

(V. RENGASAMY)
DEPUTY CONTROLLER OF PATENTS & DESIGNS

PATENT OFFICE
INTELLECTUAL PROPERTY RIGHTS BUILDING
G.S.T. ROAD, GUINDY
CHENNAI – 600 032.

FORM 2

THE PATENTS ACT, 1970.
(39 of 1970)

COMPLETE SPECIFICATION
(See Section 10)

13/CHE/04
07/JAN/04

A METHOD OF MANUFACTURING ONE-PIECE WHEEL OF 5° & 15° DROP CENTER RIMS AND THE ONE-PIECE WHEEL CONSTRUCTION

WHEELS INDIA LIMITED
PADI, CHENNAI 600 050.

Public Limited Indian Company

The following specification particularly describes the nature of invention and the manner in which it is to be performed.

FIELD OF INVENTION

This invention in general relates to road wheels of vehicles. In particular this invention relates to construction of vehicle steel wheel of 5^0 and 15^0 drop center rims used but not limited for commercial use. This invention further relates to a method of manufacturing the said type of wheel.

Tire bead seat area would have a 5^0 or 15^0 taper and profile (where tire contact is involved) as defined in the international tire and rim standards / manuals / hand books such as ETRTO, T&RA, JATMA. Whereas 15^0 drop center is mainly used for tubeless type tyre application, the 5^0 drop center rims can be used for both tube and tubeless applications. Removable flanges are not required for this design.

This invention relates to a construction, apparatus and a method of producing a one-piece wheel of $5^0$and 15^0 drop center rim, providing a generally circular steel blank from a sheet stock of pre-determined uniform thickness, the blank is preferably with a center hole pierced to a predetermined size. The blank is preformed in spinning machine to a predetermined profile & cylindrical shape, such preform is further spun and flow formed in a spinning machine, the preform being positioned between an outer roller & inner mandrel and held against the clamping plate, such inner mandrel comprise of a outboard surface which conforms to the predetermined inner diameter of the rim well, the inner & outer bead-seat and outer flange and such outer roller comprise of outboard surface which confirms to the predetermined inner diameter of the inner flange. The preform peripheral cylindrical portion is then spun against the outboard surface of the inner mandrel & outboard surface of the outer roller to a predetermined profile & form in respect of well, inner & outer bead-seats, inner & outer flanges respectively. The spun rim comprising of predetermined semi-finished well, inner & outer bead seats and inner & outer flanges is further subjected to a flow-forming & spinning operation in an spinning machine, while the disc portion being accurately located in the center hole & clamped against the outer clamping plate, the rim peripheral portion being positioned between an inner mandrel and outer roller, such inner mandrel & outer roll comprise of a outboard surface which conforms to the final profile & shape of the well, inner & outer bead seats and the inner & outer flanges, to achieve the final profile and shape of the well, inner & outer bead-seats and the outer & inner flanges.

PRIOR ART

In its most conventional form, a fabricated sheet steel wheel of 5^0 and 15^0 drop center rim, the rim inner periphery have welded or jointed central disc also made of sheet steel. The tire mounts on the outer periphery of the rim supported by the central disc, which provides a means of attachment to spindle hubs, brake drum or other like associated parts of the vehicle. It is essential that the rim and disc, in their assembled relationship, insure perfect roundness of the rim and accurate axial alignment of the rim with respect to the disc. Deviations in the respective directions being termed as "radial" and "axial" run-outs, the Vehicle manufacturers establish extremely rigid specifications in the tolerances for these dimensions.

When such wheels are manufactured in the conventional method, the rim and discs are normally made as separate components. These two components are then assembled together; the disc fixed at its outer peripheral flange to the inner periphery of the rim by welding or some other like method to form the complete wheel assembly. In the conventional method of making the rims by using a butt-welded

hoop made out of a steel strip of hot rolled sections or plate, achieving such a close tolerance on the roundness has found to be extremely difficult due to the localized "kink" in the region of butt welded joint and the spring back during the rim diameter calibration operation. Further substantial distortion due to welding the two parts requires further corrective additional costly operation to ensure that the axial alignment between the rim and the disc is held within limits. It is appreciated by the people who are skilled in the manufacturing wheels that such distortion once occurred cannot be corrected completely. Such shift in the axial alignment and also the localized kink in the rim in the region of the butt welded joint is know to produce first harmonics during vehicle running causing vibration and high noise. The axial shift between the disc and the rim also produces imbalance of the wheel causing vehicle disturbance or thumping/ shake.

Further when such wheels have been run with test overloads to induce failure, fatigue cracks have usually occurred in the center of the disc where it is attached to its supporting axle and in the welds, which have attached the rim to the disc.

Further a welded assembly does not lend itself well to the rigorous balancing and centering of the wheel. Further the butt-welded joint of the hoop of the rim for the conventional process does not always lead to an airtight construction, which is necessary for fitting tubeless tires. Further the joint also constitutes a weak point, which restricts the useful life. The use of one piece wheels made from our invention, would lead to a noticeable reduction in weight as a whole and achieving balancing and centering, besides ensuring the air-tightness necessary when using tubeless tires.

It is well recognized that wheels are not only critical to the safety of an automotive vehicle but also being an un-sprung mass has a pronounced effect on vehicle stability and driving comfort. It is thus obvious that only a one-piece wheel of 5^0 and 15^0 design and a method of manufacturing the same would satisfy the requirement as enumerated as above.

However, up to the present time none of the prior processes has enabled one-piece steel wheels of $5^0$and 15^0 drop center rims to be produced under satisfactory technical and /or economic conditions, either on account of the fact that they do not lend themselves to mass production at an attractive cost price, or on account of the fact that the wheels obtained do not satisfy the requirements of the users, strength, minimal unbalance, first harmonic content, and accuracy of the significant dimensional characteristics.

The present invention relates to a construction, apparatus and method for producing one-piece wheel of $5^0$and 15^0 drop center rim for vehicles, which lends itself particularly well to mass production and provides wheels which meet the requirements of users such as have been enumerated above. A vehicle wheel of one-piece construction requires less material input and is substantially simpler to fabricate as there is only one part that is needed to manufacture and there are no assembly & welding steps involved, thus resulting in cost savings.

OBJECTS OF THE INVENTION

Accordingly, it is an object of the present invention to provide a steel wheel of one-piece wheel of $5^0$and 15^0 drop center rim construction, a method and apparatus for making the same, which overcome the aforementioned problems in an economical and reliable manner.

It is another object of invention to provide an improved method of manufacturing of a vehicle wheel in a way that reduces manufacturing cost while providing high strength wheel.

It is further object of invention to provide for a design / construction that reduces the wheel weight substantially, yet providing the high strength wheel.

It is yet another object of invention to provide for a greater air space for a larger envelope brake components for improved braking performance.

It is still another object of invention to provide for a wheel having very low radial and lateral run outs.

Yet another object of invention is to provide for a wheel having very low first harmonic content.

It is another object of invention to provide for a wheel having very low unbalance.

It is another object of invention to provide a method whereby a family of vehicle wheels having any plurality of axial width; diameter and offset may be produced from the blanks.

It is another object of invention to provide which would improve uniformity characteristics and increased fatigue life.

A further object is to provide improved apparatus of the aforementioned character, which is economical to set-up, and adjust.

Another object of the invention is to provide an improved manufacturing system, which requires only relatively small number of process steps, which can be carried out efficiently, and economically by automated equipment.

SUMMARY OF THE INVENTION

The invention provides a method of manufacturing a one-piece wheel of 5^0 and 15^0 drop center rim of the type having well, inner & outer bead-seat and flanges wherein the said method comprises the following steps

providing a generally circular steel blank, preferably of predetermined uniform thickness and size, with a center hole pierced, and

the blank is preformed to a predetermined cylindrical shape & size by spinning & flow forming in a CNC spinning machine, the blank being positioned & clamped between an inner mandrel and a clamping plate, such inner mandrel having an outboard surface which conforms to a predetermined inner diameter wherein the well, inner & outer bead seats and the outer flange are formed in the subsequent operations, and

the spun and flow formed preform to a predetermined cylindrical shape & size is further spun in a CNC spinning machine to reduce thickness consequently to increase the width in the forward direction to a predetermined size while maintaining the predetermined inner diameter wherein the well, inner & outer bead seats and the outer flange are formed in the subsequent operations and at the same time further spinning is preformed on the peripheral portion of the cylinder to

displace the material in the backward direction to a predetermined shape & size of the inner flange, and

the preform from the previous step, is further spun in a CNC spinning machine to impart final shape and profile to the rim portion comprising of well, inner & outer bead seats and inner & outer flanges using such inner mandrel, the central line axis of which is slightly offset against the centerline of the central hole of the preform during spinning operation.

One aspect of the present invention is a unique backward & forward material displacement and use of a mandrel that is offset against the axis of rotation of the preform. The cold spinning & flow forming method for manufacturing one-piece wheel of $5^0$and 15^0 drop center rim construction, provides a generally circular steel blank from a sheet stock of pre-determined uniform thickness, the blank is preferably with a center hole pierced to a predetermined size. The blank is preformed in a spinning machine to a predetermined profile & cylindrical shape, such preform is further spun and flow formed in a spinning machine, the preform being positioned between an outer face plate & inner mandrel held against the clamping plate, such inner mandrel comprise of a outboard surface which conforms to the predetermined inner diameter of the rim, well, the inner & outer bead-seat & outer flange and such outer face plate comprise of outboard surface which confirms to the predetermined inner diameter of the inner flange. The preform peripheral cylindrical portion is then spun against the outboard surface of the inner mandrel & outboard surface of the outer roll to a pre-determined profile & form in respect of well, inner & outer bead-seats, outer & inner flanges respectively to displace the material in both backward & forward direction. The spun rim comprising of predetermined semi-finished well, inner & outer bead seats and flanges is further flow-formed and spun in a spinning machine, while the disc portion being accurately located in the center hole & clamped against the outer clamping plate, the rim peripheral portion being positioned between an inner roll and outer shaping roller, such inner mandrel & outer shaping rollers comprise of a outboard surface which conforms to the final shape of the well, inner & outer bead seats and the inner & outer flanges, to achieve the final profile and shape of the well, inner & outer bead-seats and the outer& inner flanges.

The spun wheel comprising of final well, inner & outer bead seats and before displacing the material in both backward & forward direction, the preform is subjected to such operations where the central hole, mounting holes and the vent holes are pierced to a required size.

After final rim profiling & shaping operation, the center hole and the mounting holes are machined accurately in a multi-drilling machine.

After the center hole and the mounting holes are machined accurately in a multi-drilling machine, the inner & outer flange is machined to achieve a flat or round radius on its crown edges.

The principal objects of the present invention are to provide a unique, low cost method of press forming, spinning & flow forming one-piece vehicle steel wheels and the like. Steel blank is formed from sheet stock, and is spin and flow formed in a spinning operation to reduce manufacturing costs. The spinning & flow forming technique employs tools with a simple forming surfaces, which minimizes their associated manufacturing cost, as well as repair expenses. The spin forming machine can be easily programmed to form different shapes, such that the present method is

especially suited for making specialty and/or low volume wheel designs as well as particularly well adapted for manufacturing one-piece type vehicle wheels for bulk manufacturing.

These and other advantages of the invention will be further understood and appreciated by those skilled in the art by reference to the following written specification, claims and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawing is intended to provide further understanding of invention and is incorporated in and constitutes a part of invention. The drawings illustrate an embodiment of invention and together with the description illustrate principle of invention.

The drawings should not be taken as implying any necessary limitation on the essential scope of invention.

The drawings are given by way of non-limitative example to explain the nature of the invention.

For a more complete understanding of the instant invention reference is now made to the following description taken in conjunction with accompanying drawings.

The various feature of novelty which characterize the invention are pointed out specifically in the claims which a part of description. For a better understanding of the invention, its operating advantage, specific objects obtained by its use, reference should be made to the drawings and descriptive matter is which there are illustrated and described preferred embodiments of invention.

Referring now to drawings, where like numerals designate identical or corresponding parts throughout the referred views.

Fig 1 – shows a sectional view of disc steel blank with center hole of the welded wheel of 5^0 and 15^0 drop center rim construction wheel of the prior art.

Fig 2 - shows sectional view of a spin & flow formed steel disc of the welded wheel of 5^0 and 15^0 drop center rim of the prior art

Fig 3 – shows sectional view of a finished disc of the welded wheel of 5^0 and 15^0 drop center rim of the prior art having mounting and vent hole.

Fig 4 – shows a schematic representation the welded hoop from flat plate for the manufacture of steel rims for welded wheel of 5^0 and 15^0 drop center wheels of the prior art

Fig 5 - shows a schematic representation the welded hoop from mill section for the manufacture of steel rims for welded 15^0 drop center rim of the prior art

Fig 6 - shows a schematic representation the rolling process involved in producing rims for welded wheel of 5^0 and 15^0 drop center rim of the prior art

Fig 7 - shows a schematic representation of the calibration operation of the welded wheel of 5^0 and 15^0 drop center rim of the prior art

Fig 8 - shows a schematic representation of the vent hole operation of the welded wheel of 5^0 and 15^0 drop center steel rim of the prior art

Fig 9 - shows a schematic representation of the disc and rim assembly after welding operation of the welded 5^0 and 15^0 drop center rim of the prior art.

Fig 10 – shows a perceptive view of the one-piece steel wheel for 5^0 and 15^0 drop center rims in accordance with the present invention.

Fig 11– shows a sectional view of disc steel blank with center hole of the one-piece steel wheel for 5^0 and 15^0 drop center rims in accordance with the present invention.

Fig 12 – shows a schematic representation of the first stage of spinning process of the one-piece steel wheel for 5^0 and 15^0 drop center rims in accordance with the present invention.

Fig 13 – shows a schematic representation of the spun wheel from the previous step, wherein the mounting and center hole is pierced in accordance with the present invention.

Fig 14 - shows a schematic representation of the spun wheel from the previous step wherein the vent holes are pierced in accordance with the present invention.

Fig 15- shows a schematic representation of the second stage of forward and backward displacement of material during spinning process of the one-piece steel wheel for 5^0 and 15^0 drop center rims in accordance with the present invention

Fig 16 – shows a schematic representation of the final stage of spinning processes where the well, inner & outer bead-seats and inner & outer flanges are formed to the final profile and shape in accordance with the present invention.

Fig 17 – shows a schematic representation of the machining process for providing a flat or rounded edges on the inner and outer flange crown edges.

DETAILED DESCRIPTION OF THE PRIOR ART AND THE PREFERRED EMBODIMENTS

DESCRIPTION OF THE PRIOR ART

The conventional method of producing the steel wheel is shown in Fig 1 to Fig 9. In the conventional method the disc and the rim are manufactured as separate components and then welded or jointed by other means after assembly

The steps involved in the manufacture of steel discs are blanking of the circular blank of pre-ermined thickness, spinning & flow forming and piercing the center spigot, mounting and vent holes as shown in Fig 2 and Fig 3 respectively.

The rim is manufactured either by using a flat steel plate of uniform thickness or using the profiled hot rolled steel plate as shown in Fig 4 and Fig 5. In either case the steel plate is coiled into a hoop, butt welded, joint trimmed and dressed. The hoops are roll formed in a rolling machine to impart final profile & shape to the rim as shown in Fig 6. Finally the rims are calibrated for the diameter and out-of roundness accuracy as shown in the Fig 7. The valve access hole is subsequently pierced in press as shown in Fig 8

These two components are then assembled together; the disc fixed at its outer peripheral flange to the inner periphery of the rim by welding or some other like method to form the complete wheel assembly. The wheels subsequently under goes several machining steps to machine center hole and bolt holes.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

Our preferred embodiment of invention is shown in Fig 10 to Fig 16. The following description is of the best presently contemplated mode of carrying out the invention. This description is made for the purpose of illustrating the general principles of the invention and should not be taken in a limiting sense. The scope of the invention is best determined by reference to the appended claims

The first step of manufacturing a one-piece wheel of 5^0 and 15^0 drop center rim involves a spinning and flow forming operation as shown in Fig 12, where in the steel blank of pre-determined diameter and thickness Fig 11, the blank is preferably with a center hole pierced to a predetermined size, is spun and flow formed in a CNC 4-axis spinning machine. The operation is now explained in greater detail .The preformed steel blank is held between inner mandrel M1 and the clamping plate C1. The roller R1 mounted on CNC hydraulically actuated slide, impart rolling pressure on the outer peripheral portion of the preformed blank to reduce the thickness at the required region and at the same time impart predetermined cylindrical shape and profile as per the predefined machine program. The outboard surface of the inner mandrel M1 corresponds to such predetermined cylindrical shape & profile corresponding to the inner diameter of rim portion.

The next step involves piercing the central hole, mounting & vent holes in a conventional press as shown in the Fig 13 & Fig 14.

The next step involve forward spinning to extend the cylindrical portion comprising of well, inner & outer bead seat and outer flange to an cylindrical shape of predetermined inner diameter and width as shown in Fig 15 and at the same time cylindrical portion comprising of inner flange is spun in such a way that the material is displaced in the backward direction, as shown, to a predetermined inner diameter and width. The operation is now explained in greater detail. The preform as shown in Fig 15, is spun and flow formed in a CNC 4-axis spinning machine. The preform is positioned between inner mandrel M2 and outer roll F2 and clamped prior to spinning operation by the clamping plate C2. The roller R2 mounted on CNC hydraulically actuated slide impart rolling pressure on the outer peripheral of the preformed blank to reduce the thickness at the required region and at the same time extend the cylindrical portion to a predetermined shape and profile as per the predefined machine program. The outboard surface of the inner mandrel M2 corresponds to the predetermined inner diameter of the rim while the outboard surface of the outer roll F2 corresponds to the predetermined inner diameter of the inner flange. The roller R2 is used for both forward and backward spinning as shown in the drawing.

The next step involves final profiling of the rim comprising of well, inner & outer bead seats and inner & outer flanges as shown in Fig 16 The spun rim comprising of predetermined semi-finished well, inner & outer bead seats and flanges is further formed in a spinning machine, while the disc portion being accurately located in the center hole & clamped against the outer clamping plate, the rim peripheral portion being rolled between an inner mandrel and outer shaping rollers mounted, such inner mandrel and outer rollers comprise of a outboard surfaces which conforms to the final

shape of the well, inner & outer bead seats and the inner & outer flanges, to achieve the final profile and shape of the well, inner & outer bead-seats and the outer& inner flanges. The operation is now explained in greater detail. The preform from the previous operation is located in the central hole and clamped against the clamping plate C3. The inner mandrel, the central line axis of which slightly offset against the centerline of the central hole of the preform moves in to an exact predetermined position. The outboard surface of the inner mandrel M3 corresponds to the final profile of the well and the bead seat. The shaping roll R3 mounted on a slide moves in from outward direction to form the profile of well and bead seat. At the same time the rolls R1, R2, R4 and R5 moves into position to form the profile of the inner and outer flanges.

SALIENT FEATURES OF THE INVENTION ARE AS FOLLOWS

A design / construction of a one-piece steel wheel of 5^0 and 15^0 drop center rim construction of the type having an integral disc and rim portion with inner & outer 5^0 and 15^0 bead-seat, well and the inner & outer flanges

A method of producing the wheel consists in providing a generally circular blank; spin forming the blank to a pre-determined thickness and profile. The blank is preferably with a center hole pierced to a predetermined size. The blank is spun in a spinning machine, the bank being positioned and clamped between a mandrel and a clamping plate, such inner mandrel having a outboard surface which conforms to the predetermined inner diameter of the rim comprising of well, bead seats and flanges. The blank peripheral portion is spun and flow formed against the outboard surface of the inner mandrel to the predetermined diameter as explained above.

The method has the step of spin forming the peripheral portion of the blank by engaging the same with a forming roller so as to obtain controlled thickness reduction and shape in the peripheral cylindrical portion of the blank.

The method has the step of displacing the material in backward direction, a section of the preform cylindrical peripheral portion against the outboard shaping surface of the mandrel and an outwardly positioned facing plate to form the predetermined shape of the inner flange.

The method has the step of spin forming a section of the preform cylindrical peripheral portion by engaging the same with a forming roller to form the predetermined shape of the well, bead seats and flanges.

The method has the step of spin forming the bead seat portion of the preform outboard section against the shaping surface of the mandrel to form the predetermined shape of flange.

The final profiling method has an inner mandrel, axis of rotation of which slightly offset against the axis rotation of the preform.

A method has the step wherein first-named spin forming step includes a plurality of passes of the forming roller.

A method has the step wherein after first step of spinning operation bolt holes on pierced in a conventional press.

A method has the step wherein after piercing the bolt holes, vent holes are pierced in a conventional press

The method also includes the step of providing a disc blank of substantially uniform thickness and constructed also from low carbon steel of HSLA steel composition.

Throughout this detailed description, reference is made to the tools and dies that perform the various shaping operations. Because the tooling used in each of the shaping operations is conventional devices, which are well known in the metal stamping/forming arts, detail description of the same has not been provided.

It is to be understood that the invention may assume various alternative orientations and step sequences, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification are simply exemplary embodiments of the inventive concepts defined in the appended claims. Hence, specific dimensions and other physical characteristics relating to the embodiments disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise.

Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be regarded as falling within the scope of the invention as defined by the claims that follow.

WE CLAIM

1. A method of manufacturing a one-piece wheel of 5^0 and 15^0 drop center rim of the type having well, inner & outer bead-seat and flanges wherein the said method comprises the following steps

   providing a generally circular steel blank, preferably of predetermined uniform thickness and size, with a center hole pierced, and

   the blank is preformed to a predetermined cylindrical shape & size by spinning & flow forming in a CNC spinning machine, the blank being positioned & clamped between an inner mandrel and a clamping plate, such inner mandrel having an outboard surface which conforms to a predetermined inner diameter wherein the well, inner & outer bead seats and the outer flange are formed in the subsequent operations, and

   the spun and flow formed preform to a predetermined cylindrical shape & size is further spun in a CNC spinning machine to reduce thickness consequently to increase the width in the forward direction to a predetermined size while maintaining the predetermined inner diameter wherein the well, inner & outer bead seats and the outer flange are formed in the subsequent operations and at the same time further spinning is preformed on the peripheral portion of the cylinder to displace the material in the backward direction to a predetermined shape & size of the inner flange, and

   the preform from the previous step, is further spun in a CNC spinning machine to impart final shape and profile to the rim portion comprising of well, inner & outer bead seats and inner & outer flanges using such inner mandrel, the central line axis of which is slightly offset against the centerline of the central hole of the preform during spinning operation.

2. The method as claimed in claim 1 wherein spin forming the peripheral of the blank by engaging the same with a forming roller so as to obtain controlled thickness reduction and shape in the peripheral and inner portion of the blank.

3. The method as claimed in claims 1 & 2 wherein the material is displaced in the backward direction during spinning a portion of the preform peripheral cylindrical portion against the outboard surface of an outwardly positioned outer roll to form a predetermined cylindrical portion of the inner flange.

4. The method as claimed in claims 1 to 3 wherein spin forming a portion of the blank peripheral portion by engaging the same with a forming roller to form the final shape of the well.

5. The method as claimed in claims 1 to 4 wherein spin forming a portion of the blank peripheral portion by engaging the same with a forming roller to form the final shape of the bead seat.

6. The method as claimed in claims 1 to 5 wherein spin forming the bead seat portion of the preformed blank is carried out by engaging the same with a forming roller against the outboard surface of the outer mandrel to form the final shape of outer flange.

7. The method as claimed in claims 1 to 6 wherein the first-named spin forming step consists a plurality of passes of the forming roller.

8. The method as claimed in claims 1 to 7 wherein after finish spinning operation boltholes are pierced in a conventional press.

9. The method as claimed in claims 1 to 8 wherein after piercing the center hole, bolt holes, vent holes are pierced in a conventional press.

10. The method as claimed in claims 1 to 9 wherein after piercing the center, bolt holes & vent holes, the center hole and the mounting holes are accurately machined to required size.

11. The method as claimed in claims 1 to 10 wherein after machining the center hole and the mounting holes to an accurate required size, the inner & outer flange crown edges are machined to provide a radius or a flat.

12. The method as claimed in claims 1 to 11 wherein the disc blank provided is of low carbon steel or HSLA steel composition.

13. The method as claimed in claims 1 to 12 wherein a butt-welded hoop of predetermined diameter, width and thickness can also be used instead of a blank.

14. The method as claimed in claims 1 to 13 wherein the butt-welded hoop of predetermined diameter, width and thickness can also be used to manufacture the rim part alone.

15. A one-piece wheel of 5^0 and 15^0 drop center rim having an integral disc and rim portion is made from a circular blank or hoop by the method as claimed in claims 1 to 14.

16. A method of manufacturing a one-piece wheel of 5^0 and 15^0 drop center rim of the type having well, inner & outer bead-seat and flanges substantially as herein described with reference to the accompanying drawings.

Dated this the 7th day of January 2004.

For WHEELS INDIA LIMITED

B. Srivatsan
VICE PRESIDENT (FINANCE) & SECRETARY

Signature of Applicant

ABSTRACT

This invention relates to a construction, apparatus and a method of producing a one-piece wheel of 5°and 15° drop center rim, providing a generally circular steel blank from a sheet stock of pre-determined uniform thickness, the blank is preferably with a center hole pierced to a predetermined size. The blank is preformed in spinning machine to a predetermined profile & cylindrical shape, such preform is further spun and flow formed in a spinning machine, the preform being positioned between an outer roller & inner mandrel and held against the clamping plate, such inner mandrel comprise of a outboard surface which conforms to the predetermined inner diameter of the rim well, the inner & outer bead-seat and outer flange and such outer roller comprise of outboard surface which confirms to the predetermined inner diameter of the inner flange. The preform peripheral cylindrical portion is then spun against the outboard surface of the inner mandrel & outboard surface of the outer roller to a predetermined profile & form in respect of well, inner & outer bead-seats, inner & outer flanges respectively. The spun rim comprising of predetermined semi-finished well, inner & outer bead seats and inner & outer flanges is further subjected to a flow-forming & spinning operation in an spinning machine, while the disc portion being accurately located in the center hole & clamped against the outer clamping plate, the rim peripheral portion being positioned between an inner mandrel and outer roller, such inner mandrel & outer roll comprise of a outboard surface which conforms to the final profile & shape of the well, inner & outer bead seats and the inner & outer flanges, to achieve the final profile and shape of the well, inner & outer bead-seats and the outer& inner flanges.

IS/C HOE/04
07 JAN/04

NAME OF THE APPLICANT: WHEELS INDIA LIMITED

SHEET 1 OF 3 SHEETS

Application No. 0013/CHE/04

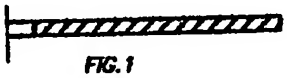


FIG.1

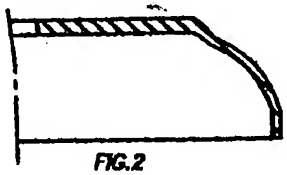


FIG.2

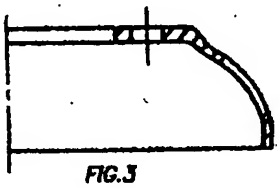


FIG.3

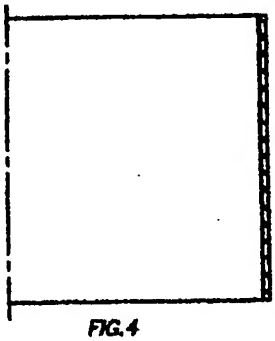


FIG.4

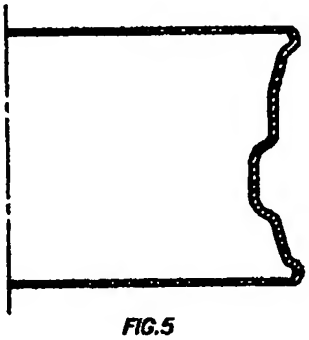


FIG.5

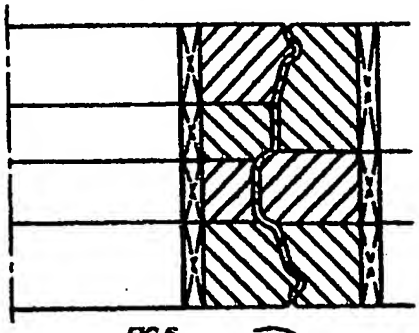


FIG.6

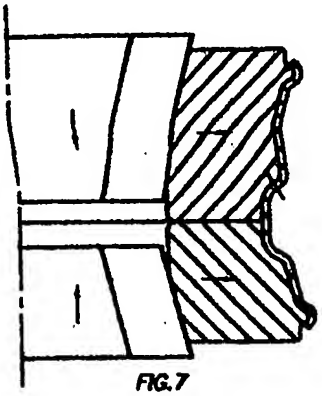


FIG.7

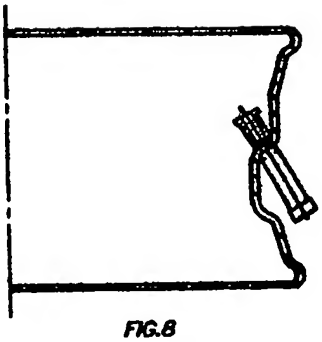


FIG.8

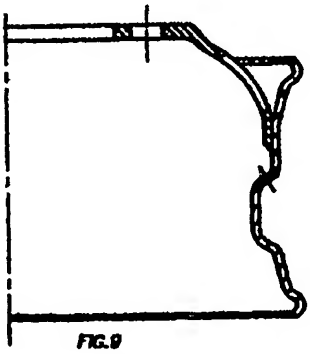


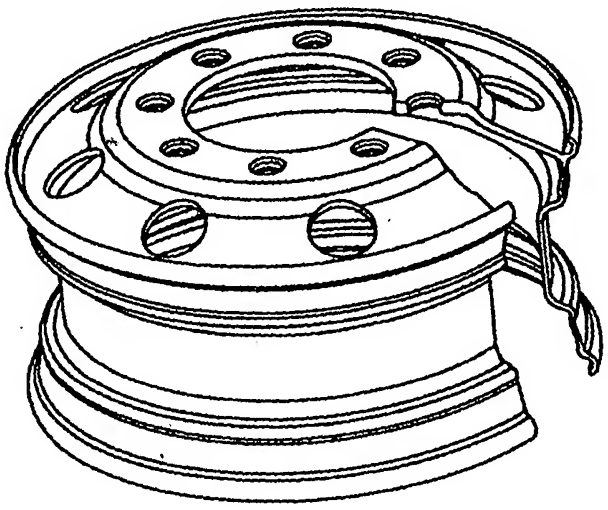
FIG.9

PRIOR ART 15° DROP CENTRE STEEL WHEEL

SIGNATURE OF APPLICANT: (S.SRIVATHSAN)

NAME OF THE APPLICANT: WHEELS INDIA LIMITED

Best Available Copy



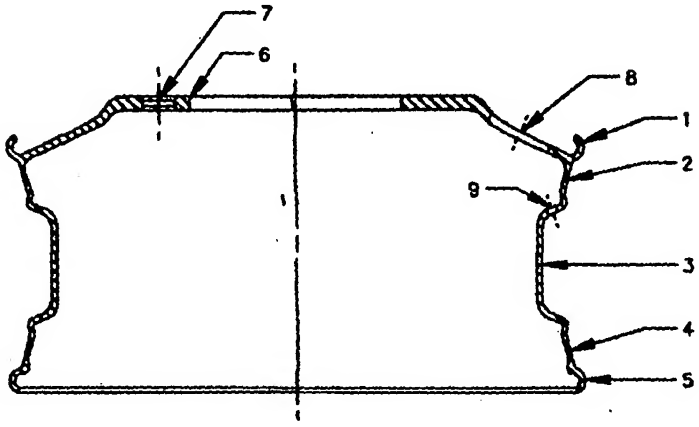


FIG.10

SIGNATURE OF APPLICANT: (S. SRIVATHSAN)
NAME OF THE APPLICANT: WHEELS INDIA LIMITED

Best Available Copy

NAME OF THE APPLICANT: WHEELS INDIA LIMITED

SHEET 3 OF 3 SHEETS

Application No. 0013/CHE/04

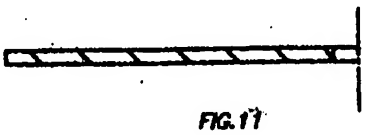


FIG.11

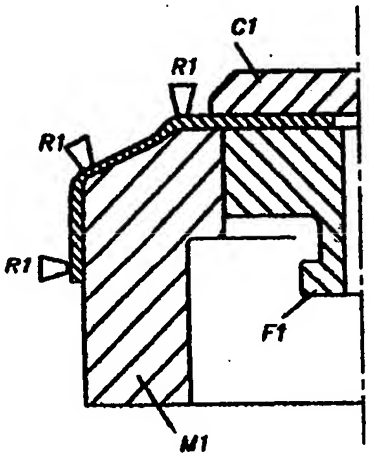


FIG.12

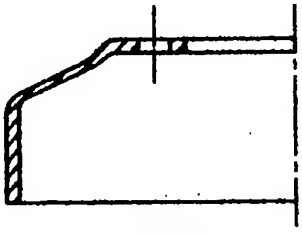


FIG.13

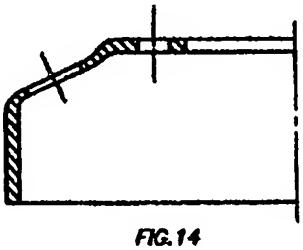


FIG.14

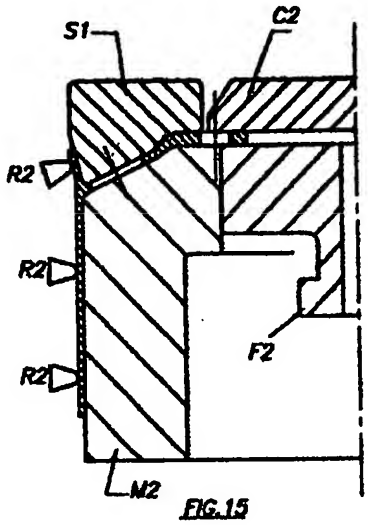


FIG.15

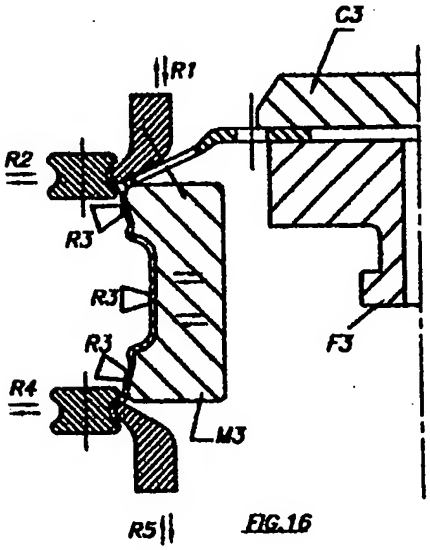


FIG.16

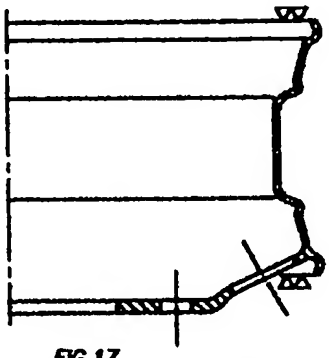


FIG.17

ONE PIECE WHEEL OF 15° DROP CENTRE RIM

SIGNATURE OF APPLICANT: (S. SRIVATHSAN)

NAME OF THE APPLICANT: WHEELS INDIA LIMITED

EXHIBIT B

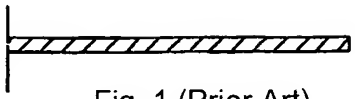


Fig. 1 (Prior Art)

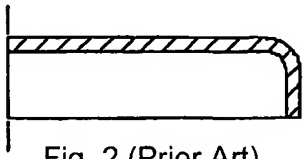


Fig. 2 (Prior Art)

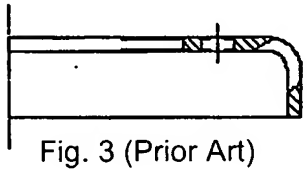


Fig. 3 (Prior Art)

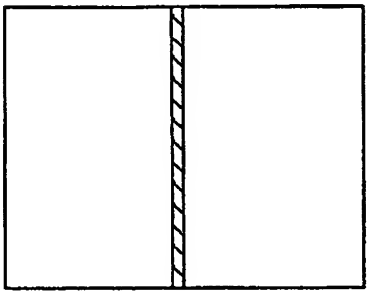


Fig. 4 (Prior Art)

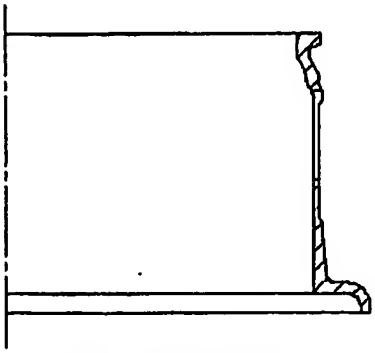


Fig. 5 (Prior Art)

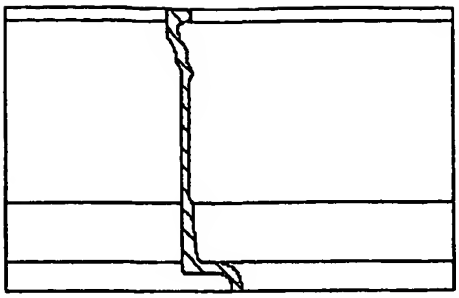


Fig. 6 (Prior Art)

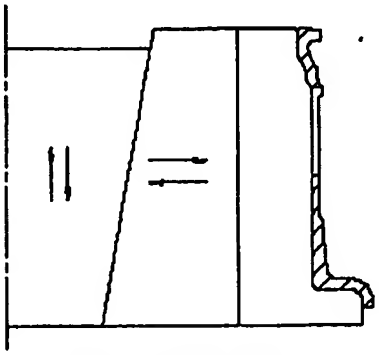


Fig. 7 (Prior Art)

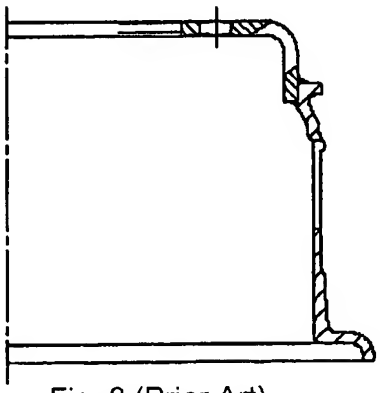


Fig. 8 (Prior Art)

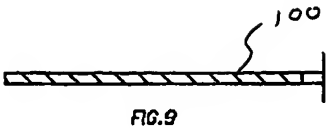


FIG.9

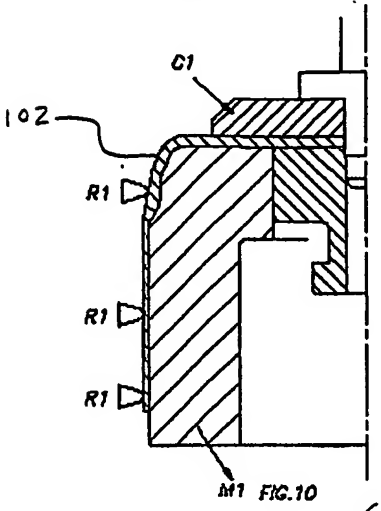


FIG.10

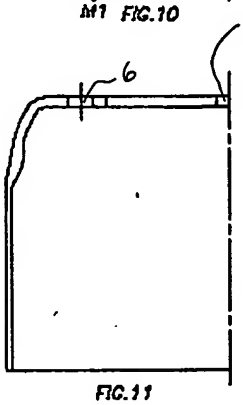


FIG.11

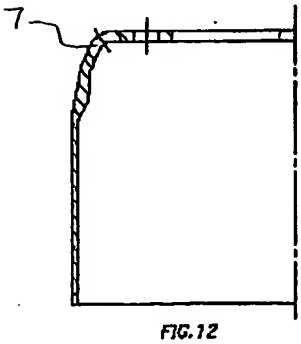


FIG.12

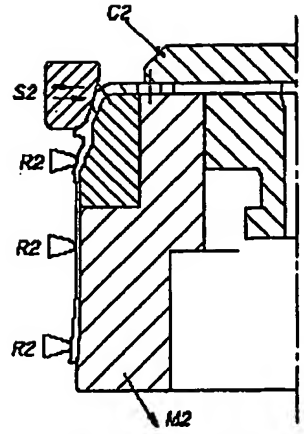


FIG.13

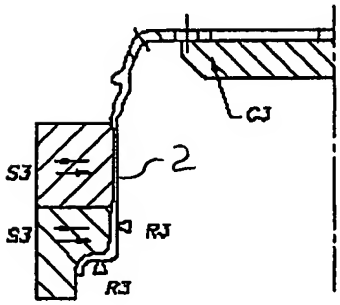


FIG.14

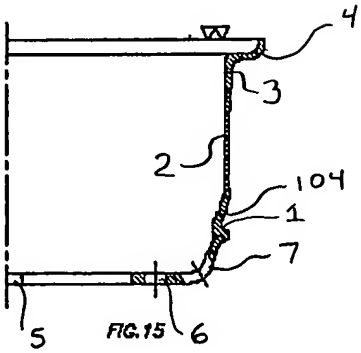
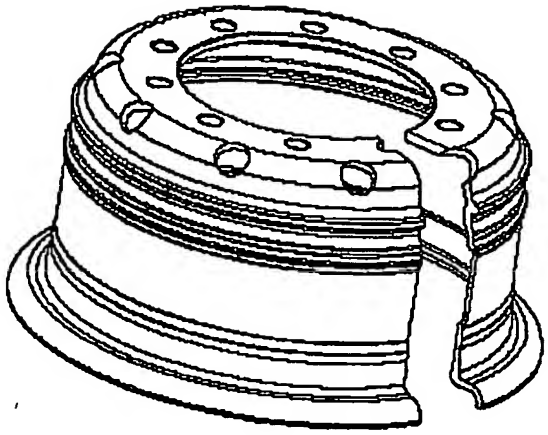


FIG.15



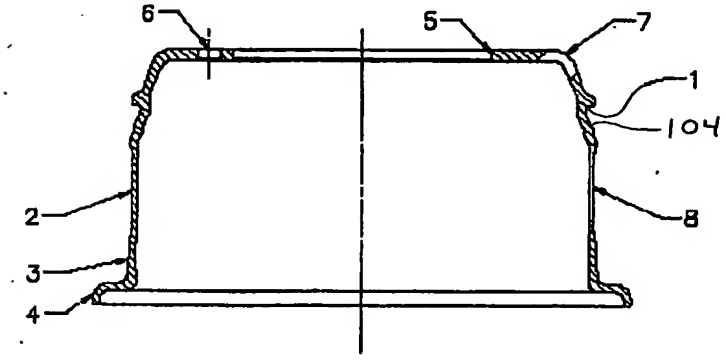


FIG.1B